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**SYSTEM AND METHOD FOR REDUCING  
APPARENT HEIGHT OF A BOARD SYSTEM**

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5                    **SYSTEM AND METHOD FOR REDUCING  
APPARENT HEIGHT OF A BOARD SYSTEM**

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10                    **Field Of The Invention**

10                    The present invention generally relates to a system and a method for reducing  
apparent height of a board system.

15                    **Background Of The Invention**

15                    Space is always at a premium in an electronic housing. For example, as the  
technology in the wireless communications industry improves, the wireless communications  
devices and, in particular, the housings of the wireless communications devices are becoming  
more miniaturized. The shrinking dimensions of the housing are in stark contrast to the  
increasing dimensions and, in particular, the increasing height of some components on the  
main board of the wireless communications device that are becoming more powerful and are  
20                    being asked to perform multiple complex tasks.

20                    Conventional solutions may include, for example, using larger housing dimensions  
or using less powerful components which have smaller dimensions. Such conventional  
solutions are often inconvenient and undesirable to consumers. Alternatively, the cost of the  
wireless communications devices can be increased dramatically by researching, developing  
25                    and marketing a powerful component that has smaller dimensions. However, in a  
competitive arena such as the wireless communications industry, consumers may be reluctant

to absorb such additional costs.

In another example, computer industry standards relating to the dimensions of a printed circuit board (e.g., motherboards, expansion boards) have already been set. Accordingly, as computer tasks become more intricate, the hardware mounted on the printed circuit boards also becomes more complex. As components mounted on the printed circuit board become more powerful, the size and, in particular, the height of the components becomes greater. In some cases, the apparent height of the component may exceed the standard dimensions. Thus, the printed circuit board with component mounted thereon may not fit in the standard board slot or electronic housing.

The conventional solutions have proven to be unsatisfactory. For example, by using less powerful components with, for example, shorter dimensions, the printed circuit board can fit in the standard electronic housing or board slot. However, such a technique fails to take advantage of available and more powerful components. Alternatively, conventional methods may include designing custom electronic housings or custom board slots. Such conventional methods have a disadvantage of being costly and incompatible with industry adopted standards and with components and/or parts that adhere to the industry adopted standards. In still another alternative, the cost and time to market of the computer or server can be increased dramatically by researching, developing and marketing a powerful component that has smaller dimensions. The computer industry is another competitive arena in which costs are reluctantly absorbed by consumers and in which the technology is changing so rapidly that the costs in time and the risks of obsolescence can be quite significant.

### Summary Of The Invention

The present invention provides a system and a method for reducing apparent height of a board system and alleviates to a great extent the disadvantages of conventional systems and methods.

In an exemplary embodiment, the present invention may include, for example, a carrier, a component, a printed circuit board and/or a solder material. The component is mounted on a first side of the carrier. The printed circuit board has a hole that is structured to accommodate the component. The solder material solders the carrier to the printed circuit board and provides a structural bond between the carrier and the printed circuit board. At least one portion of the solder material provides an electrical coupling between the carrier and the printed circuit board and at least one portion of the component is maintained in the hole after the carrier is soldered to the printed circuit board.

The present invention has an advantage of reducing an apparent height of the component on a printed circuit board and/or reducing a total height of a board system. Thus, for example, components, that typically could not be mounted on a printed circuit board due to particular space limitations within a housing, can be added to the printed circuit board without exceeding the particular space limitations.

These and other features and advantages of the present invention will be appreciated from review of the following detailed description of the present invention, along with the accompanying figures in which like reference numerals refer to like parts throughout.

### **Brief Description Of The Drawings**

FIG. 1 shows a side view illustrating an exemplary embodiment of a board system according to the present invention;

FIG. 2 shows a perspective view illustrating an exemplary embodiment of a carrier system according to the present invention;

FIG. 3 shows a top view illustrating an exemplary embodiment of the board system according to the present invention;

FIG. 4A shows a side view illustrating a conventional board system;

FIG. 4B shows a side view illustrating an exemplary embodiment of the board system according to the present invention;

FIG. 5 shows a side view illustrating an exemplary embodiment of the board system according to the present invention; and

FIG. 6 shows a side view illustrating an exemplary embodiment of the board system according to the present invention.

### **Detailed Description Of The Invention**

FIG. 1 shows an exemplary embodiment of a system and method for reducing apparent height of a board system 100 according to the present invention. The board system 100 may include, for example, a printed circuit board (PCB) 110, a carrier system 120 and/or a solder material 130. The carrier system 120 may include, for example, a carrier 140, a component 150 and/or a paste material 160. The component 150 is coupled to the carrier 140 via the paste material 160 or via conventional coupling means known to one of ordinary

skill in the art. The paste material 160 may provide an electrical connection between the component 140 and the carrier 140. The PCB 110 may include, for example, a hole that is structured to accommodate the component 150. When the carrier system 120 is coupled to the PCB 110 via the solder material 130, the component 150 may be, at least partly, disposed in the hole 115 of the PCB 110. The solder material 130 may provide a structural bond between the carrier system 120 and the PCB 110. In addition, at least a portion of the solder material 130 may provide an electrical coupling between the carrier system 120 and the PCB 110 and, in particular, between the carrier 140 and the PCB 110. Accordingly, an electrical path is formed between the component 150 and the PCB 110 via the paste material 160, the carrier 140 and the solder material 130. This electrical path may be the sole electrical path between the component 150 and the PCB 110.

In an exemplary embodiment, the system 100 may be part of a larger system such as, for example, a computer system, a wireless communications system or any other system that employs printed circuit boards. Thus, for example, a wireless communications device may include, for example, an antenna that is coupled to the component 150 such as, for example, a duplexer 170, via the PCB 110. As illustrated in FIG. 2, the duplexer 170 may include a plurality of ports of which only two 180, 190 are shown. Although shown on side walls of the duplexer 170, the ports may be disposed any of the walls of the duplexer 170 and may extend across combinations of walls. In the duplexer 170, one of the ports 180 may be reserved, for example, as an input or an output for the antenna the wireless communications device. Another port 190 may be dedicated, for example, as an output port for a reception branch of the communications circuitry mounted or printed on the PCB 110. In yet another

port, the duplexer 170 may be dedicated, for example, as an output port for a transmission branch of the communications circuitry, for example, mounted or printed on the PCB 110.

Other ports may also be provided such as, for example, an electrical ground port, which are well known to one of ordinary skill in the art, but are not described further herein.

5 As shown in FIG. 2, the paste material may be spread across the base of the duplexer 170. The paste material 160 may be spread across the entire base of the duplexer 170 or in portions of the base of the duplexer 170. For example, if a port is located on the base of the duplexer 170 or if the port 180, 190 extends from the side wall of the duplexer 170 to a portion of the base, then the paste material 160 may be spread in the region of that portion  
10 of the base. If applicable, the paste material 160 may be exposed to raised temperatures which aid in melting the paste material 160. As the paste material 160 cools, it can, for example, harden into a structural bond. The paste material 160 may also provide an electrical connection between the duplexer 170 and the carrier 140. For example, the carrier 140 may include electrical traces 200 and pads 210. The electrical traces 200 may extend  
15 beneath the duplexer 170. The paste material 160 may provide the electrical connection between the ports 180, 190 of the duplexer 170 and the electrical traces 200 and pads 210 of the carrier 140.

FIG. 3 illustrates a top view of another exemplary embodiment of the board system 100 according to the present invention. The duplexer 170 is illustrated as having two ports  
20 180, 190 (although the duplexer 170 may have additional ports not shown). The ports 180, 190 are disposed on the base of the duplexer 170, but may also extend to, for example, a side wall of the duplexer 170 or may entirely be disposed on a side wall of the duplexer 170. The

paste material 160 is spread across portions of the base of the duplexer 170 that are in the region of the ports 180, 190. The duplexer 170 is mounted on the carrier 140 such that the ports 180, 190 come in contact with or are coupled to the traces 200 of the carrier 140. The paste material 160, which may be heated to at least its melting temperature and then cooled, may provide a structural bond between the duplexer 170 and the carrier 140. In addition, the paste material 160 may also provide an electrical connection between the ports 180, 190 and the traces 200. For example, the paste material 160 may include solder material.

The PCB 110 includes the hole 115 through which the duplexer 170 at least partly extends as illustrated in FIG. 3. The PCB 110 is also shown with electrical pads 220 disposed on a bottom side of the PCB 110. Although not shown, the electrical pads 220 are coupled to other circuitry and/or components disposed on the PCB 110. A portion of the solder material 130 is disposed on at least a portion of the electrical pads 210 of the carrier 140. The solder material 130 may be in the form, for example, of a ball, bump and/or mass.

The carrier system 120 is brought up towards the PCB 110 such that the solder material 130 is in contact with the electrical pad of the PCB 110. The solder material 130 is heated to at least its melting temperature before being cooled. The solder material 130 may, for example, have a lower melting temperature than the paste material 160. Thus, the solder material 130 may be heated to a temperature that is at least above the melting temperature of the solder material 130, but that is below the melting temperature of the paste material 160.

Thus, the solder material 130 may provide a structural bond as well as an electrical connection between the electrical pads of the carrier 140 and the electrical pads of the PCB 110. In fact, the solder material 130 may provide the only structural bond between the



carrier 140 and the PCB 110. The solder material 130 may provide the only electrical connection between the carrier 140 and the PCB 110. Thus, the solder material 130 may provide the only electrical connection between the duplexer 170 and the PCB 110.

FIG. 4a shows a conventional board system with the duplexer 170 mounted on the PCB 110. Illustrated heights include a duplexer height  $h_d$  and a PCB height  $h_{pc}$ . Accordingly, a total height  $h_t$  of the board system may be given by the relation:

$$h_t = h_d + h_{pc} .$$

The apparent height  $h_a$ , which extends from the PCB 110 to the top of the duplexer 170, is given by the relation:

$$h_a = h_d .$$

FIG. 4b shows an exemplary embodiment of the board system 100 according to the present invention. Illustrated heights include the duplexer height  $h_d$ , the PCB height  $h_{pc}$ , a carrier height  $h_c$  and a solder material height  $h_s$ . Accordingly, a total height  $h_t$  of the board system 100 may be given by the relation:

$$h_t = h_d + h_c .$$

In an exemplary embodiment, the carrier height  $h_c$  of the board system 100 may be less than the PCB height  $h_{pc}$ , thus the total height  $h_t$  of the board system 100 is less than the total height  $h_t$  of the conventional board system. In addition, the board system 100 has a first apparent height  $h_{a1}$ , which extends from the PCB 110 to the top of the duplexer 170, and a second apparent height  $h_{a2}$ , which extends from the bottom of the PCB 110 to the bottom of the carrier 140, that may be given by the relations:

$$h_{a1} = h_d - h_{pc} - h_s , \text{ and}$$

$$h_{a2} = h_s + h_c .$$

The first apparent height  $h_{a1}$  is definitely less than the apparent height of the conventional board system. Furthermore, the second apparent height  $h_{a2}$  is typically less than the apparent height of the conventional board system since the solder material height  $h_s$  and the printed circuit board height  $h_{pc}$  are usually much smaller than duplexer height  $h_d$ .

FIG. 5 illustrates another exemplary embodiment of the board system 100 according to the present invention. The duplexer 170 has been modified to include a first portion 230 and a second portion 240. The second portion 240 includes a protrusion 250 that may extend laterally beyond the lateral reach of the first portion 230. Duplex ports 180, 190 may be disposed on, for example, at least the top of the protrusion 250. Accordingly, the solder material 130 can couple structurally and/or electrically the duplex ports 180, 190 to the electrical pads of the 220 of the PCB 110. The modified structure of the duplexer 170 reduces the need for using the carrier 140.

FIG. 6 illustrates another exemplary embodiment of the board system 100 according to the present invention. The board system 100 includes the PCB 110 which includes a recess 260. The recess 260 may be formed via molding, cutting, shaving or any other method known to one of ordinary skill in the art. The duplexer 170 is mounted on the PCB 110 in the recess 260. The electrical coupling of the duplexer 170 to the PCB 110 may be achieved using, for example, conventional methods known to one of ordinary skill in the art.

Thus, it is seen that systems and methods for reducing apparent height of a board with a component are provided. One skilled in the art will appreciate that the present invention can be practiced by other than the preferred embodiments which are presented in this

